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Patentanmeldung Nr. Patent application No. Demande de brevet n°

03076378.3 ✓

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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Voltage reduction in electrowetting by addition of surfactants

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Voltage reduction in electrowetting by addition of surfactants

Introduction

In electrowetting-based devices high actuation voltages are still an issue. Especially for variable lenses based on electrowetting to be for used in portable applications these voltages must be as low as possible to avoid that additional electronics must be used to drive the lens. These extra electronics increase the cost of the device. One of the options to decrease the required voltage is to use liquids with lower surface tensions. Equation (1) shows how the voltage can be influenced by changing the surface tensions.

$$\gamma_{oil/water}\cos\theta = \gamma_{oil/wall} - \gamma_{water/wall} + \frac{1}{2}\frac{\varepsilon_0\varepsilon_r}{d}V^2 \qquad (1)$$

where the γ are the various surface tensions, θ is the contact angle between the meniscus and the wall of the fluid chamber. The dominating term influencing the contact angle is the $\gamma_{oil/water}$. Depending on the choice of the liquids only a limited choice of discrete values for $\gamma_{oil/water}$ is possible. Apart from the correct surface tension the liquids must fulfil also a series of other requirements like appropriate refractive indices, density, melting points etc. It is difficult to fulfil all these requirements.

Technical problem

The problem is how to change the interfacial tension of a liquid without affecting the other properties of the liquid significantly.

Solution

We propose to dissolve surfactants in the liquids. These surfactants change the interfacial surface tensions between the liquids and/or the liquids and the wall of the fluid chamber. By changing the surface tensions the contact angle in the off-state can be tuned as well as the voltage required to obtain a certain change in contact angle. Surfactants can for instance be used in liquid-based variable-focus lenses. A schematic drawing of such a lens is shown in figure 1.

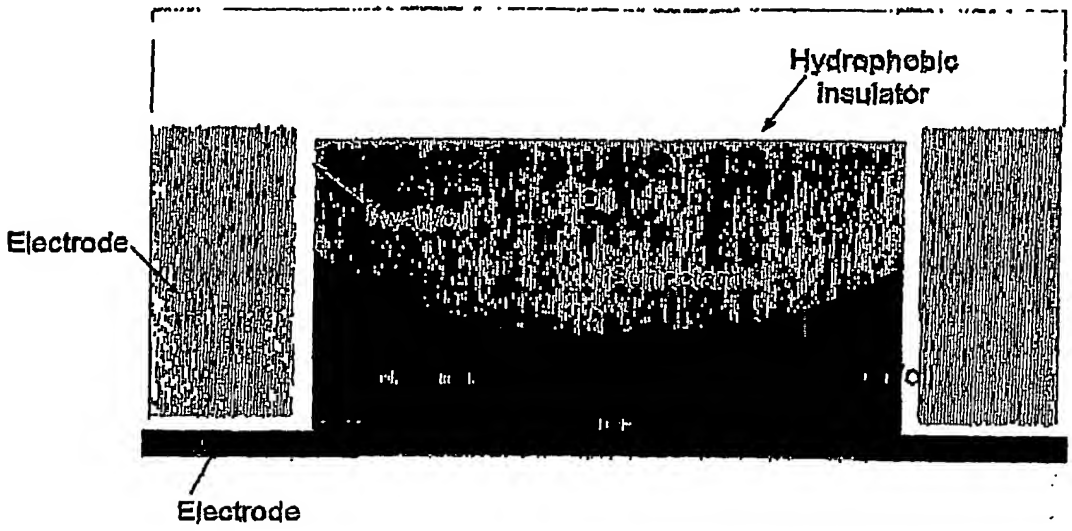

Figure 1. Schematic drawing of a variable-focus lens with indication of the various interfacial surface tensions.

There are three interfacial surface tensions that can be influenced:

1. $\gamma_{oil/water}$
2. $\gamma_{oil/wall}$
3. $\gamma_{water/wall}$

$\gamma_{oil/water}$ is the only surface tension that influences the dependence of the change in contact angle on the voltage. A lower $\gamma_{oil/water}$ lowers the voltage needed to effect a certain change in contact angle.
$\gamma_{oil/wall}$ and $\gamma_{water/wall}$ influence the contact angle in the off-state.

An example of a surfactant that can influence $\gamma_{oil/water}$ is an alcohol, e.g. decanol.
If the wall consists of a fluorocarbon (e.g. AF1600) in combination with a hydrocarbon oil, $\gamma_{oil/wall}$ can be influenced e.g. by molecules with a hydrocarbon part and a fluorocarbon part. With the same wall $\gamma_{water/wall}$ can be influenced by molecules with a polar head and a fluorocarbon tail, e.g. a fluorinated alcohol. Surfactants can decrease surface tensions significantly and thus driving voltages can decrease significantly by using surfactants. As surfactants predominantly influence interfaces, they are needed in very small amounts, thereby hardly influencing bulk properties of the liquids.

Application
The invention can be used to lower the driving voltage for various kinds of electrowetting elements, for instance variable-focus lenses, variable diaphragms, variable filters, gratings, beam deflectors and electrowetting-based displays. Examples of such elements have been

disclosed in international patent application no. IB03/00222 (PH-NL020163), European patent applications no. 02078939.2 (PH-NL020947), no. 02080387.0 (PH-NL021251) and no. 02080060.3 (PH-NL021187). These electrowetting elements can be used in devices such as optical scanning devices, cameras, mini-cameras in mobile phones, displays, etc.

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Claims:

1 An optical element comprising a fluid chamber including a first body of a first fluid and a second body of a second fluid, the two bodies being separated by a meniscus, the position and/or shape of which is electrically controllable, the first fluid being electrically conducting and the second fluid being electrically non-conducting, characterized in that at least one of the first and second liquids comprises a surfactant.

2 An optical element according to Claim 1, wherein the surfactant affects the surface tension between the first liquid and the second liquid.

3 An optical element according to Claim 2, wherein the surfactant is an alcohol.

4 An optical element according to Claim 1, wherein the surfactant affects the surface tension between the second liquid and a wall of the fluid chamber.

5 An optical element according to Claim 1, wherein the surfactant affects the surface tension between the first liquid and a wall of the fluid chamber.